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Influence of oats and oat products in phase I and II diets on growth performance of weanling pigs

Abstract

Two experiments were conducted to determine the nutritional value of oats and oat products in diets of weanling pigs. In Exp. 1, 115 weanling pigs (avg initial body wt of 12.4 lb and avg age of 19 d) were used in a 38-d growth assay. Treatments were 1) a corn-soybean meal-based control, 2) ground oats, 3) oat groats, and 4) oat flour. Phase I diets were formulated to 1.55% lysine, and at d 10 postweaning the pigs were switched to a Phase II diets formulated to 1.3% lysine. At d 24 postweaning, all pigs were changed to a sorghum-based Phase III diet. The diets were fed in pelleted form. For Phase I, pigs fed the oat products tended to have greater efficiencies of gain compared to pigs fed corn. Pigs fed the reduced fiber oat products (groats and flour) were more efficient than pigs fed ground whole oats, and the most refined oat product (oat flour) tended to support the greatest efficiencies of gain (8% greater ADG and 13% greater F/G than the corn control). These same trends for pigs fed oat flour were noted in Phase II and for the overall experiment (I.e., d 0 to 38). In Exp. 2, 172 weanling pigs (avg initial body wt of 12.5 lb and avg age of 19 d) were used in a second 38-d growth assay. Treatments were 1) a com-soybean meal-based control, 2) ground oats, 3) roasted oats, 4) oat groats, 5) steam-flaked oat groats, and 6) oat flour. The data indicated that roasting decreased the nutritional value of ground oats. However, steam-flaking improved the nutritional value of oat groats. Feeding diets formulated with processed oat products (i.e., steam-flaked oat groats and oat flour) improved F/G through Phase II (e.g., 6% greater efficiency of gain compared to the corn-based control), but much of that advantage was lost during Phase III while the pigs were fed the same sorghum- based diet. In conclusion, the most refined oat products (steam-flaked oat groats and oat flour) supported better F/G than com in Phases I and II. However, cost must be continuously balanced against the improved performance to ensure that use of these oat products is economically viable.; Swine Day, Manhattan, KS, November 17, 1994

Keywords

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INFLUENCE OF OATS AND OAT PRODUCTS IN PHASE I AND II DIETS ON GROWTH PERFORMANCE OF WEANLING PIGS

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Summary

Two experiments were conducted to determine the nutritional value of oats and oat products in diets of weanling pigs. In Exp. 1, 115 weanling pigs (avg initial body wt of 12.4 lb and avg age of 19 d) were used in a 38-d growth assay. Treatments were 1) a corn-soybean meal-based control, 2) ground oats, 3) oat groats, and 4) oat flour. Phase I diets were formulated to 1.55% lysine, and at d 10 postweaning the pigs were switched to a Phase II diets formulated to 1.3% lysine. At d 24 postweaning, all pigs were changed to a sorghum-based Phase III diet. The diets were fed in pelleted form. For Phase I, pigs fed the oat products tended to have greater efficiencies of gain compared to pigs fed corn. Pigs fed the reduced fiber oat products (groats and flour) were more efficient than pigs fed ground whole oats, and the most refined oat product (oat flour) tended to support the greatest efficiencies of gain (8% greater ADG and 13% greater F/G than the corn control). These same trends for pigs fed oat flour were noted in Phase II and for the overall experiment (i.e., d 0 to 38). In Exp. 2, 172 weanling pigs (avg initial body wt of 12.5 lb and avg age of 19 d) were used in a second 38-d growth assay. Treatments were 1) a corn-soybean meal-based control, 2) ground oats, 3) roasted oats, 4) oat groats, 5) steam-flaked oat groats, and 6) oat flour. The data indicated that roasting decreased the nutritional value of ground oats. However, steam-flaking improved the nutritional value of oat groats. Feeding diets formulated with processed oat products (i.e., steam-flaked oat groats and oat flour) improved F/G through Phase II (e.g., 6% greater efficiency of gain compared to the corn-based control), but much of that advantage was lost during Phase III while the pigs were fed the same sorghum-based diet. In conclusion, the most refined oat products (steam-flaked oat groats and oat flour) supported better F/G than corn in Phases I and II. However, cost must be continuously balanced against the improved performance to ensure that use of these oat products is economically viable.

(Key Words: Pigs, Carbohydrate, Starter, Oat, Growth.)

Introduction

Oats is a popular field crop grown throughout much of the United States. During the past decade, researchers at KSU have developed and promoted a three-phase diet regimen (depending on age at weaning) for feeding nursery pigs. In the 1981 KSU Swine Day (page 26), it was stated that pigs fed a corn-sorghum meal-based diet gained 5% slower than pigs fed diets with steam-rolled or ground oats. However, in that experiment, simple diets were fed to pigs weaned at 6 wk of age. Therefore, two experiments were conducted to determine the effects of various oat products in Phase I (d 0 to 10) and II (d 10 to 24) complex nursery diets on growth performance of pigs weaned at 3 weeks of age or less.

Procedures

In Exp. 1, 115 weanling pigs (avg body wt of 12.4 lb and avg age of 19 d) were allotted by weight, sex, and ancestry with six pigs per pen and five pens per treatment. Treatments were 1) a corn-soybean meal-based control, 2) ground oats, 3) oat groats,

and 4) oat flour. The ground oat treatment was a "full-fiber" ingredient. Oat groats were the dehulled portions of the whole oats, and the oat flour was further refined with the oat bran removed. Phase I diets were formulated to 1.55% lysine, .9% Ca, and .8% P. At d 10, the pigs were switched to Phase II diets with 1.3% lysine, .9% Ca, and .8% P, using the same carbohydrate sources as in Phase I. At d 24, all pigs were put on a sorghum-based Phase III diet formulated to 1.15% lysine, .9% Ca, and .8% P. All diets were fed in pelleted form. In Exp. 2, 172 weanling pigs (avg body wt of 12.5 lb and avg age of 19 d) were allotted by weight, sex, and ancestry with six pigs per pen and five pens per treatment. Treatments were 1) a corn-soybean meal-based control, 2) ground oats, 3) roasted oats, 4) oat groats, 5) steam-flaked oat groats, and 6) oat flour. Phase I, II, and III diets were formulated to the same nutrient concentrations as in Exp. 1. All carbohydrate sources were ground through a hammermill using an 1/16" screen. The roasted oats were ground through a hammermill and then reconstituted to 30% moisture. This product was pelleted and passed through a Jet-Pro® roaster with an exit temperature of 260°F. For steam-flaked oat groats, the product was heated and softened with steam and rolled flat through a steam flaker with an exiting temperature of approximately 200°F.

All pigs were housed in 4 ft × 5 ft pens with woven-wire flooring. Room temperatures were 90, 87, 84, 80, and 75°F for wk 1 to 5, respectively. Each pen had a self-feeder and nipple waterer to allow ad libitum consumption of fed and water. The pigs and feeders were weighed on d 0, 10, 24, and 38 to allow calculations of average daily gain (ADG), average daily feed intake (ADFI), and feed to gain ratio (F/G).

Results and Discussion

Experiment 1. No differences were detected for ADG or ADFI during Phase I (d 0 to 10) of the experiment. However, pigs fed the diet with corn tended to have poorer F/G ($P<.06$) than those fed the oat products. Also, pigs fed the diet with ground oats had poorer F/G ratio ($P<.02$) than those fed diets with oat groats and oat flour. The removal of fiber (hulls and bran) for the oat groats and flour treatments probably was the reason for improved efficiency of gain.

For Phase II (d 10 to 24), ADFI was greater ($P<.02$) for pigs fed the ground oats compared to pigs fed diets with oat groats and oat flour. Diets with ground whole oats would have lower energy concentrations and, thus, pigs would eat more to consume similar amounts of energy. Pigs fed diets with oat flour had improved ADG and F/G ($P<.01$) compared to those fed diets with oat groats.

Data from the combined Phases I and II periods (d 0 to 24) indicated that pigs fed ground oats consumed more feed ($P<.08$) and had poorer F/G ($P<.02$) than pigs fed oat groats and oat flour. Pigs fed oat flour had improved ADG and F/G compared to those fed oat groats ($P<.02$).

During Phase III (d 24 to 38), no differences occurred for ADG, ADFI, or F/G among pigs fed the various carbohydrate sources in Phases I and II. However, overall data (d 0 to 38) indicated that pigs initially fed diets with ground oats tended to consume more feed ($P<.07$) and converted feed to gain with less efficiency than those fed oat groats and oat flour. Also, pigs initially fed diets with oat flour tended to have improved F/G ($P<.08$) compared to those fed oat groats.

Experiment 2. During Phase I, pigs fed diets with reduced fiber (groats- and flour-based diets) had greater ADG and ADFI than those fed ground oats and roasted oats ($P<.01$). Also, pigs fed ground oats had greater ADG and ADFI ($P<.04$) than pigs fed roasted oats. Thus, it appeared that heat treatment (roasting) of the whole oats reduced their nutritional value.

During Phase II, pigs fed roasted oats continued to have poorer ADG and ADFI ($P<.02$) compared to pigs fed ground oats. Pigs fed diets with ground oats and roasted oats had poorer F/G ($P<.01$) compared to pigs fed reduced-fiber treatments, and pigs

fed steam-flaked oat groats had better F/G ($P<.001$) than those fed ground oat groats.

The combined data from Phases I and II indicated that pigs fed ground oats and roasted oats had poorer ADG and F/G ($P<.03$) than pigs fed reduced fiber treatments. Pigs fed ground oats had improved ADG and ADFI ($P<.01$) compared to pigs fed roasted oats. Also, pigs fed steam-flaked oat groats had improved F/G ($P<.001$) compared to those fed ground oat groats. The improvement in nutritional value with heat treatment (steam flaking) of the oat groats probably can be attributed to denaturation of protein and gelatinization of starch. Perhaps the lack of response to heat treatment (roasting) for whole oats was because of overprocessing. A slightly dark appearance for the roasted oats product was noted when the diets were mixed.

Overall (d 0 to 38), pigs initially fed corn tended to have greater ADG and ADFI ($P<.08$ and $<.09$, respectively) compared to pigs fed oat products. Pigs initially fed ground oats had improved ADG and ADFI ($P<.02$) compared to those fed roasted oats. Also, pigs initially fed steam-flaked oat groats tended to have improved F/G ($P<.06$) compared to pigs given ground oat groats.

In summary, oat products are suitable substitutes for corn in diets for weanling pigs. Further processing of oat products, especially steam-flaking and removal of fiber to yield oat flour, resulted in improved nutritional value of Phases I and II nursery diets (e.g., equal ADG but 6% greater efficiency of gain compared to the ground corn control diet). Thus, depending on cost, processed and refined oat products can be used to improve F/G of weanling pigs during Phases I and II (d 0 to 24) postweaning. However, their generally greater price dictates careful comparison of diet costs before oat products are used.

Table 1. Diet Composition, [ab]

Ingredient	Phase I[c] (d 0 to 10)	Phase II[d] (d 10 to 24)	Phase III[e] (d 24 to 38)
Corn	38.70	51.87	---
Sorghum	---	---	60.22
Soybean meal	15.00	20.00	33.60
Dried whey	20.00	20.00	---
Lactose	10.00	---	---
Spray dried plasma protein	8.00	---	---
Spray dried blood meal	2.00	2.00	---
Soybean oil	2.00	2.00	2.00
Monocalcium phosphate	1.88	1.55	1.97
Limestone	.68	.78	.92
Vit/Min/Ab[f]	1.47	1.58	1.29
DL-methionine	.17	.08	---
Lysine-HCl	.10	.14	---
Total	100.00	100.00	100.00

[a]For Exp. 1, ground oats, oat groats, and oat flour were used to replace corn, lysine-HCl, monocalcium phosphate, and limestone in Phases I and II.
[b]For Exp. 2, ground oats, roasted oats, oat groats, and oat flour were used to replace corn, lysine-HCl, monocalcium phosphate, and limestone in Phases I and II.
[c]Phase I diets were formulated to 1.55% lysine, .9% Ca, and .8% P.
[d]Phase II diets were formulated to 1.3% lysine, .9% Ca, and .8% P.
[e]Phase III diets were formulated to 1.15% lysine, .9% Ca, and .8% P. This diet was fed from d 24 to 38 of both trials.
[f]Vit/Min = KSU vitamin and trace mineral premixes. Antibiotic (Ab) was 150 g/ton apramycin in Phase I and 50 g/ton carbadox in Phases II and III.

Table 2. Effects of Oat Products on Performance of Nursery Pigs (Exp. 1)[a]

Item	Corn	Ground oats	Ground oat groats	Oat flour	CV	Contrasts[bc] 1	2	3
Phase I (d 0 to 10)								
ADG, lb	.60	.60	.66	.65	12.6	--	--	--
ADFI, lb	.67	.67	.68	.64	13.3	--	--	--
F/G	1.12	1.10	1.03	.98	7.0	.06	.02	--
Phase II (d 10 to 24)								
ADG, lb	.98	1.00	.84	1.04	8.1	--	--	.01
ADFI, lb	1.42	1.49	1.29	1.34	8.7	--	.02	--
F/G	1.45	1.49	1.51	1.29	7.0	--	--	.01
Phases I and II (d 0 to 24)								
ADG, lb	.82	.84	.77	.88	7.8	--	--	.02
ADFI, lb	1.11	1.15	1.03	1.04	9.1	--	.08	--
F/G	1.35	1.37	1.34	1.20	5.1	--	.02	.01
Overall (d 0 to 38)								
ADG, lb	.86	.88	.80	.89	12.4	--	--	--
ADFI, lb	1.38	1.45	1.29	1.33	9.7	--	.07	--
F/G	1.61	1.65	1.61	1.50	6.1	--	--	.08

[a]A total of 115 pigs (six pigs/pen and five pens/treatment) with an average initial body wt of 12.4 lb and an average final body wt of 70 lb.
[b]Contrasts were: 1) corn vs oat products; 2) ground oats vs reduced fiber oat products (groats and flour); and 3) oat groats vs oat flour (oat bran removed).
[c]Dashes indicate P>.10.

Table 3. Effects of Oat Products on Performance of Nursery Pigs (Exp 2)[a]

Item	Corn	Ground oats	Roasted oats	Ground oat groats	Steam-flaked oat groats	Oat flour	CV	Contrasts[bc] 1	2	3	4	5
Phase I (d 0 to 10)												
ADG, lb	.53	.53	.47	.54	.54	.55	7.7	--	.01	.04	--	--
ADFI, lb	.48	.47	.43	.49	.49	.47	4.6	--	.001	.01	.05	--
F/G	.91	.90	.90	.90	.92	.86	7.4	--	--	--	--	--
Phase II (d 10 to 24)												
ADG, lb	1.11	1.12	1.00	1.08	1.10	1.10	6.5	--	--	.02	--	--
ADFI, lb	1.49	1.54	1.37	1.49	1.34	1.41	7.1	--	--	.02	--	.04
F/G	1.33	1.37	1.37	1.38	1.22	1.29	4.2	--	.01	--	--	.001
Phases I and II (d 0 to 24)												
ADG, lb	.87	.87	.78	.86	.87	.87	7.0	--	.03	.001	--	--
ADFI, lb	1.07	1.09	.97	1.07	.99	1.02	8.6	--	--	.01	--	.06
F/G	1.23	1.25	1.24	1.24	1.14	1.17	4.6	--	.001	--	--	.001
Overall (d 0 to 38)												
ADG, lb	1.07	1.05	.98	1.05	1.06	1.01	10.0	.08	--	.02	.08	--
ADFI, lb	1.56	1.57	1.46	1.55	1.50	1.47	8.2	.09	--	.01	--	--
F/G	1.45	1.49	1.49	1.48	1.42	1.46	5.0	--	.01	--	--	.06

[a]A total of 172 pigs (six pigs/pen and five pens/treatment) with an avg initial body wt of 12.5 lb.
[b]Contrasts were: 1) corn vs oat products; 2) ground oats and roasted oats vs reduced fiber oat products (ground/steam-flaked groats and flour); 3) ground oats vs roasted oats; 4) dehulled oat products (groats and steam-flaked groats) vs refined oat flour (oat bran removed); and 5) ground oat groats vs steam-flaked oat groats.
[c]Dashes = P>.10.